UNIVERSITI PUTRA MALAYSIA

UTILIZATION OF LEGUME FORAGES AS PROTEIN SUPPLEMENTS FOR RUMINANTS

BODEE KHAMSEEKHIEW

FP 2001 11

UTILIZATION OF LEGUME FORAGES AS PROTEIN SUPPLEMENTS FOR RUMINANTS

By

BODEE KHAMSEEKHIEW

Thesis Submitted in Fulfilment of the Requirement for the Degree of
Master of Science in the Faculty of Agriculture
Universiti Putra Malaysia

April 2001

Adalah disahkan bahawa kami telah membaca tesis ini yang bertajuk "Utilisation of Legume forages as Protein Supplements for Ruminants" Oleh Bodee Khamseekhiew dan berpendapat bahawa tesis ini adalah memuaskan daripada segi skop, kualiti dan persembahan sebagai memenuhi syarat keperluan untuk ijazah Master Sains.

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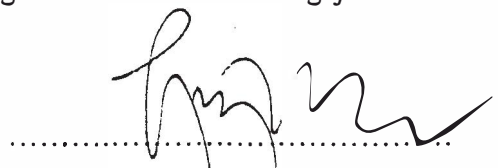

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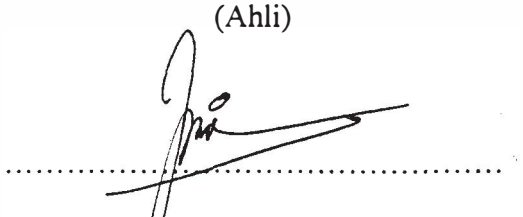

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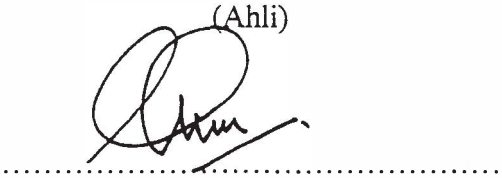

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Nota: Para pemeriksa dikehendaki menelity / menyemak tesis pelajar terlebih dahulu sebelum menandatangani borang ini.

I wish to dedicate this thesis to my beloved parents, Poh Chile and Mae Paa Khamseekiew, who always understand and give me loving support.

Abstract of the thesis presented to the senate of Universiti Putra Malaysia in fulfilment of the requirement for the Degree of Master of Science

UTILIZATION OF LEGUME FORAGES AS PROTEIN SUPPLEMENTS FOR RUMINANTS

By

BODEE KHAMSEEKHIEW

April 2001

Chairman : Associate Professor Liang Juan Boo, Ph.D.

Faculty : Agriculture

An assessment of four legume forages, namely *Leucaena hybrid-Bahru* (*Leucaena-Bahru*), *Leucaena hybrid-Rendang* (*Leucaena-Rendang*), *Gliricidia sepium* (*G. sepium*) and *Arachis pintoi* (*A. pintoi*) as protein supplements for ruminants was conducted in four studies. In experiment 1, chemical composition and ruminal and intestinal digestibilities of the test materials were determined. Crude protein (CP) contents of the two *Leucaena* hybrids and *G. sepium* were over 20%, while that for *A. pintoi* was marginally lower. Tannin content of *Leucaena* hybrids (averaged of 7.9%) was significantly ($p<0.05$) higher than those of *G. sepium* (3.7%) and *A. pintoi* (2.0%). Ruminal and intestinal digestibilities of *G. sepium* and *A. pintoi* were significantly ($p<0.05$) higher than those of *Leucaena* hybrids, while digestibility differences between *G. sepium* and *A. pintoi* were smaller. Total tract digestibility for *G. sepium* was the highest (85.6%), followed closely by *A. pintoi*

(78.4%). The above values were significantly higher ($p<0.05$) than those of the two *Leucaena* hybrids (averaged 52.2%).

In experiment 2, the effects of levels of legume supplementation on fibre digestion and rumen environment were examined. The results showed that increasing legume supplementations improved ruminal NH_3N and VFA concentrations and DM digestion. The results of this experiment indicate 40% supplementation would provide on optimal level of NH_3N for microbial synthesis.

In experiment 3, acceptability (palatability) of the three legumes was examined using the choice feeding technique in sheep. The sheep showed highest preference for *Leucaena-Bahru*, followed by *A. pintoi* and *G. sepium*, but intake of *A. pintoi* the highest, followed by *Leucaena-Bahru* and *G. sepium*.

In the final experiment, the effects of increasing levels of legume supplementation on intake, N balance and performance in sheep were examined. Fibre (using OPF as test material) and total DM intakes and average daily gain (ADG) increased with increasing levels of *Leucaena-Bahru* and *A. pintoi* supplementation. *Leucaena* supplemented animals excreted higher urinary N as compared to their counterparts supplemented with *A. pintoi*. This had resulted in lower N retentions for *Leucaena* treated animals which were reflected by the lower ADG. The study on microbial N (MN) productions using purine derivative (PD) excretion technique showed that MN production was positively correlated with

increased level of legume supplementation, but the response was not significant between legume types.

The four legumes could be useful protein supplements to improve the efficiency of utilisation of fibrous agricultural byproducts such as OPF in ruminant diets. However, the low digestibility of the two psyllid resistant *Leucaena* hybrids, together with their low N retention and body weight gain when fed to animal have cast doubt over the actual usefulness of the above *Leucaena* hybrids. Tannin was postulated to be the primary factor affecting the low digestibility and the efficiency of utilisation of the *Leucaena* hybrids. However, the above postulation requires further investigations.

Abstrak tesis yang dikemukkakan kepada Senat Universiti Putra Malaysia sebagai memenuhi syarat keperluan untuk Ijazah Master Sains

PENGGUNAAN FORAJ LEGUM SEBAGAI SUPLEMEN PROTEIN UNTUK RUMINAN

Oleh

BODEE KHAMSEEKHIEW

April 2001

Pengerusi : Profesor Madya Liang Juan Boo, Ph.D.

Fakulti : Pertanian

Satu penilaian telah dilakukan ke atas empat jenis foraj legum, iaitu hibrid *Leucaena-Bahru* (*Leucaena-Bahru*), hibrid *Leucaena-Rendang* (*Leucaena-Rendang*), *Gliricidia sepium* (*G. sepium*) dan *Arachis pintoi* (*A. pintoi*) sebagai bahan penambah protein untuk ruminan. Dalam kajian pertama, kandungkan kimia serta nilai cerna daripada rumen dan usus kecil bagi foraj legum tersebut telah ditentukan Kandungan protein kasar (CP) daripada kedua-dua hibrid *Leucaena* dan *G. sepium* masing-masingnya melebihi 20%, manakala bagi *A. pintoi* kandungannya lebih rendah. Kandungan tannin bagi kedua-dua hibrid *Leucaena* dengan purata sebanyak 7.9% didapati lebih tiggi ($p<0.05$) daripada *G. sepium* (3.7%) dan *A. pintoi* (2.0%). Nilai cerna rumen dan usus kecil bagi *G. sepium* dan *A. pintoi* adalah lebih tinggi ($p<0.05$) daripada kedua-dua hibrid Leucaena. Walau bagaimanapun, perbezaan nilai cerna *G. sepium* didapati paling tinggi (85.6%), diikuti oleh *A. pintoi* (78.4%).

Nilai-nilai ini ternyata lebih tinggi ($p<0.05$) daripada kedua-dua hibrid *Leucaena* dengan purata 52.5%.

Kajian kedua menentukan kesan aras penambahan legum terhadap percernaan serabut dan persekitaran rumen. Hasil yang diperolehi menunjukkan peningkatan penambahan legum telah meninggikan kandungan nitrigen-ammonia (NH_3N) dan kepekatan asid lemak meruap (VFA) rumenserta nilai cerna bahan kering. Hasil kajian ini juga menunjukkan penambahan pada aras 40% memberikan kandungan NH_3N paling optimum bagi sintesis mikrob.

Dalam kajian ketiga, penerimaan (palatabiliti) tiga jenis legum telah diuji pada biri-biri melalue kaedah pemakanan pilihan. Biri-biri didapati lebih menggemari *Leucaena-Bahru*, diikuti *A. pintoi* dan *G. sepium*. Walau bagaimanapun, ia memakan lebih banyak *A. pintoi*, diikuti Leucaena-Bahru dan *G. sepium*.

Dalam kajian terakhir, kesan penambahan aras legum terhadap pengambilan makanan, imbangan N dan prestasi biri-biri telah diselidiki. Kandungan serabut (OPF), jumlah pengambilan bahan kering dan pertambahan berat badan (ADG) didapati meningkat dengan peningkatan aras Leucaena-Bahru dan *A. pintoi*. Ternakan yang diberi penambahan Leucaena menghasilkan lebik banyak N urin dibandingkan dengan ternakan yang diberi makan *A. pintoi*. Ini menyebabkan retensi N pada ternakan yang diberi makan Leucaena menjadi rendah sehingga menurunkan ADG. Kajian terhadap pengeluaran N mikrob (MN) menggunakan teknik pembebasan derivatif purin (PD) menunjukkan pengeluaran MN adalah berkat

rapat dengan peningkatan aras legum. Walaupun begitu, rangsangan ini tidak nyata dari segi statistik di antara jenis legum.

Secara kesimpulannya, berasaskan kandungan kimia, keempat-empat legum yang dikaji merupakan penambah protein yang baik bagi ruminan bagi meningkatkan kecekapan penggunaan bahan-bahan sampingan pertanian berserabut seperti OPF. Walau bagaimanapun, kerendahan nilai cerna kedua-dua jenis hibrid *Leucaena* yang "rentan psyllid" ini, disokong pula dengan kerendahan retensi N dan penurunan berat badan memaksa pengolahan semula dari segi faedah legum berkenaan dalam pemakanan ternakan. Tannin diramalkan menjadi fakfor utama yang merendahkan nilai cerna dan merencatkan lecekapan penggunaan hibrid *Leucaena*. Walau bagaimanapun, andaian ini memerlukan kajian lanjutan.

ACKNOWLEDGEMENTS

I wish to express my appreciation and sincere gratitude to my supervisor, Associate Professor Dr. Liang Juan Boo for his invaluable guidance, constructive criticisms, and continuous encouragement. My deep appreciation also go to the members of my supervisory committee, Associate Professor Dr. Zainal Aznam bin Mohd.

Development Institute (MARDI), for their continuous interest, helpful suggestion and advice throughout this research project and in the preparation of this thesis.

I am indebted to Associate Professor Dr.

permission to use his metabolism cases during my research. Thanks are also due to Dr.

analyses.

My appreciation to Professor Dr.

Thailand and Dr.

their useful suggestions and encouragement at the beginning of my study. I

acknowledge the useful discussion with Professor Dr.

on several points in this thesis and Dr.

preparing the abstract in Bahasa Malayu.

Special thanks go to the staff of MARDI for their assistance in collecting the fodder materials.

Rahman and Saparin bin Demin of the Nutrition Laboratory, is gratefully acknowledged. My personal thanks are extended to my fellow graduate students and all Thai students in UPM particularly, Mr. Opart Pimpa, Dr. Suthipong Pruangka, Dr. Mongkon Ta_oun, Ms Cheunsikah Chemong and Ms Benchamaporn Wongsuban for their friendly guidance.

Finally, my deepest gratitude to my parents, Poh Chile and Mae Paa Khamseekhiew for their understanding and moral support during the study.

I certify that an Examination Committee met on 13th April 2001 to conduct the final examination of Bodee Khamseekhiew on his Master of Science thesis entitled "Utilisation of Legume Forages as Protein Supplements for Ruminants" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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Date: 30 APR 2001

This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirement for the degree of Master of Science.

MOHD. GHAZALI MOHAYIDIN, Ph.D.
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Date:

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

(BODEE KHAMSEEKHIEW)

Date: 24/04/2001

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LIST OF ABBREVIATIONS

ADG	- Average Daily Gain
ADF	- Acid Detergent Fibre
ADL	- Acid Detergent Lignin
ANF	- Anti-Nutritive factors
ANOVA	- Analysis of Varience
AOAC	- Association Official Agricultural Chemists
ARC	- Agricultural Research Council
DDMI	- Digestible Dry Matter Intake
DMD	- Dry Matter Digestibility
DHP	- 3-Hydroxy-4 (1H)-piridone
EE	- Ether Extract
HT	- Hydrolysable Tannin
LWG	- Live Weight Gain
NAS	- National Academy of Sciences
NDF	- Neutral Detergent Fibre
NRC	- National Research Council
OPF	- Oil Palm Fronds
SAS	- Statistical Analysis System
VFA	- Volatile Fatty Acids

CHAPTER I

GENERAL INTRODUCTION

Ruminant livestock production in Southeast Asia farming systems is highly dependent on the utilisation of natural forages and crop residues. The natural forages are generally low in yield and of poor quality particularly during the dry seasons. Similarly, the crop residues are low in digestibility and are inadequate to sustain high animal productivity. One of the strategies to improve animal productivity and efficiency under the above situation is to increase efficiency of utilisation of the low quality forages and crop residues through appropriate feed supplementation to enhance a balance supply of nutrients in the basal diet.

Two main categories of feed supplements are high energy and high protein supplements. The former consists of oil seeds, tubers and grains of high nitrogen (N) free extract and degradable nutrient with low in protein, while protein supplements are feedstuffs containing more than 20% protein or protein equivalent. Protein supplement can either come from true protein or non-protein nitrogen sources. Protein feeds are generally expensive and their use as N supplement is determined by the need of animal and economics.

One alternative way to reduce cost of concentrate supplements is to make better use of legume forages, which can be grown easily in the tropics. The ability of protein supplements to enhance livestock productivity of many ruminant species in the tropics has been well reported (Robertson, 1988; Ahn, 1990; Reed *et al.*,1990;

Muinga *et al.,* 1992). Besides, tropical leguminous shrubs have multiple uses such as for fuelwood, weed control, erosion control, land stabilisation and fencing material (Leng, 1995).

Recently, legume forages that exhibit desirable fodder characteristics are been given research priority in many tropical countries. These legumes are mainly from the genera, *Acacia, Albizia, Desmanthus, Desmodium, Gliricidia, Leucaena, Prosopis* and *Sesbania* (Brewbaker and Hutton, 1979; Brewbaker, 1986).

In Malaysia, *Gliricidia sepium* is highly productive, well adapted to acid soils and used as shade plant for cocoa and coffee plants (Wong and Anuar, 1999). Similarly, *Arachis pintoi* has adapted to a wide range of climate and soil conditions, even under heavy grazing (Stur and Ndikamana, 1993). Planting of *A. pintoi* has been encouraged because of its value as a forage and a shade tolerant ground cover in the humid areas (Cook *et al*, 1993). In Malaysia it has been introduced and planted as ground cover in oil palm plantations and as an ornamental plants (Wong, 1996*)*.

Leucaena leucocephala is the most widely used species as fodder shrub for increased animal production in the tropics. However, Leucaena is susceptible to psyllid attack. As a result, two new hybrids, *Leucaena hybrid-Bahru* (*Leucaena-Bahru*) and *Leucaena hybrid–Rendang* (*Leucaena-Rendang*) which have been shown to be well adapted to acid soil and psyllid resistance were recently released (Wong, 1998). Information on the nutritive value of the two new hybrids is lacking and thus there is a need for a systematic investigation on the forage quality aspects of utilisation.